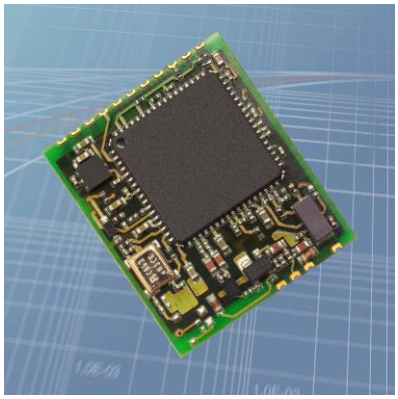
GPS Receivers A1037-A

A description of Tyco Electronics'
GPS module A1037-A

User's Manual

Version 2.0
Hardware Revision 01



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Revision History

Rev.	Date	Description
1.0	11-10-06	Initial Draft.
1.1	08-09-06	Final product specification implemented
1.2	09-22-06	Minor changes (storage temperature, spell check) Packaging details added
1.3	11-28-06	Additional info “Connection of RF Signal”
1.4	12-08-06	Application not antenna current limiter
1.6	03-14-07	Some minor changes
2.0	03-20-07	New design
	mm-dd-yy	

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1 Introduction

Tyco Electronics' GPS module A1037-A is a highly integrated GPS receiver module that can be used as an SMT component. It is capable to receive signals from up to 12 GPS satellites and transferring them into position and timing information that can be read over a serial port. This new generation of GPS module combines small size and high-end GPS functionality at low power consumption:

- Operable at 3.3V / 50mA (typ.) @ 1fix per second
- Small form factor of 19 x 16.2 mm (0.75" x 0.64")
- Cost-effective antenna input
- Single-sided SMD component, for reflow soldering
- Tape & reel packaging

The A1037-A GPS receivers are available as off-the-shelf components, 100% tested and shipped in standard tape-and-reel package.

1.1 Label

The A1037-A label holds the following information:

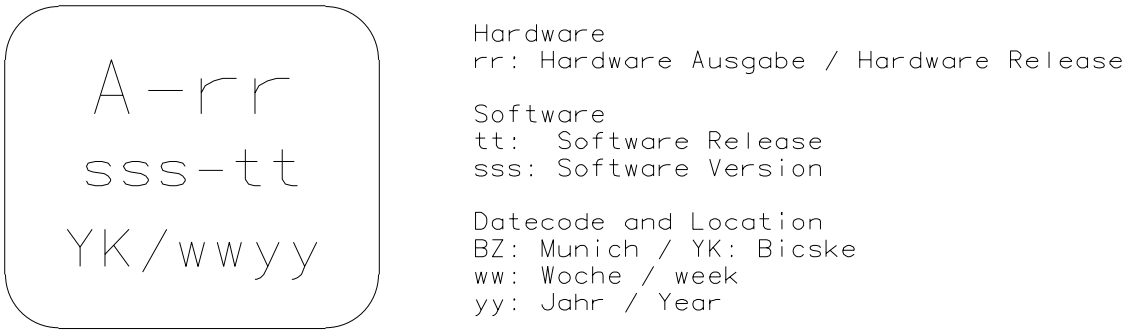


Figure 1: A1037-A label

1.2 Characteristics

The modules are characterized by the following parameters.

Channels		12, parallel tracking
Frequency		L1 (= 1575 MHz)
Position Accuracy	Stand alone	3m CEP (SA off)
Time To First Fix – TTFF (theoretical minimum values; values in real world may differ)	Obscuration recovery (1)	1s
	Hot start (2)	< 3s
	Warm (3)	< 32s
	Autonomous / cold (4) (5)	< 60s

Table 1: A1037 characteristics

(1) The calibrated clock of the receiver has not stopped, thus it knows precise time (to the µs level).
(2) The receiver has estimates of time/date/position and valid almanac and ephemeris data.
(3) The receiver has estimates of time/date/position and recent almanac.
(4) The receiver has no estimate of time/date/position, and no recent almanac.
(5) To improve TTFF, the receiver allows setting of time/date, position, almanac and ephemeris

A1037-A Mechanical dimensions	Length Width Height	19mm, 0.75” 16.24mm, 0.64” 2.4mm, 0.095”
A1037-A Weight		1g, < 0.05oz

Table 2: A1037-A dimensions and weight

1.3 Handling Precautions

The GPS receiver module A1037-A is sensitive to electrostatic discharge (ESD). Please handle with appropriate care.

2 Ordering Information

2.1 GPS Receiver A1037-A

The order number is built as follows:

- **V23993A1037A**

V23993 stands for Tyco Electronics wireless and communication products, A1037A for the A1037-A module.

2.2 Packing

2.2.1 Packaging of the A1037-A

The A1037-A GPS module comes in a tape and reel package suitable for pick and place machines.

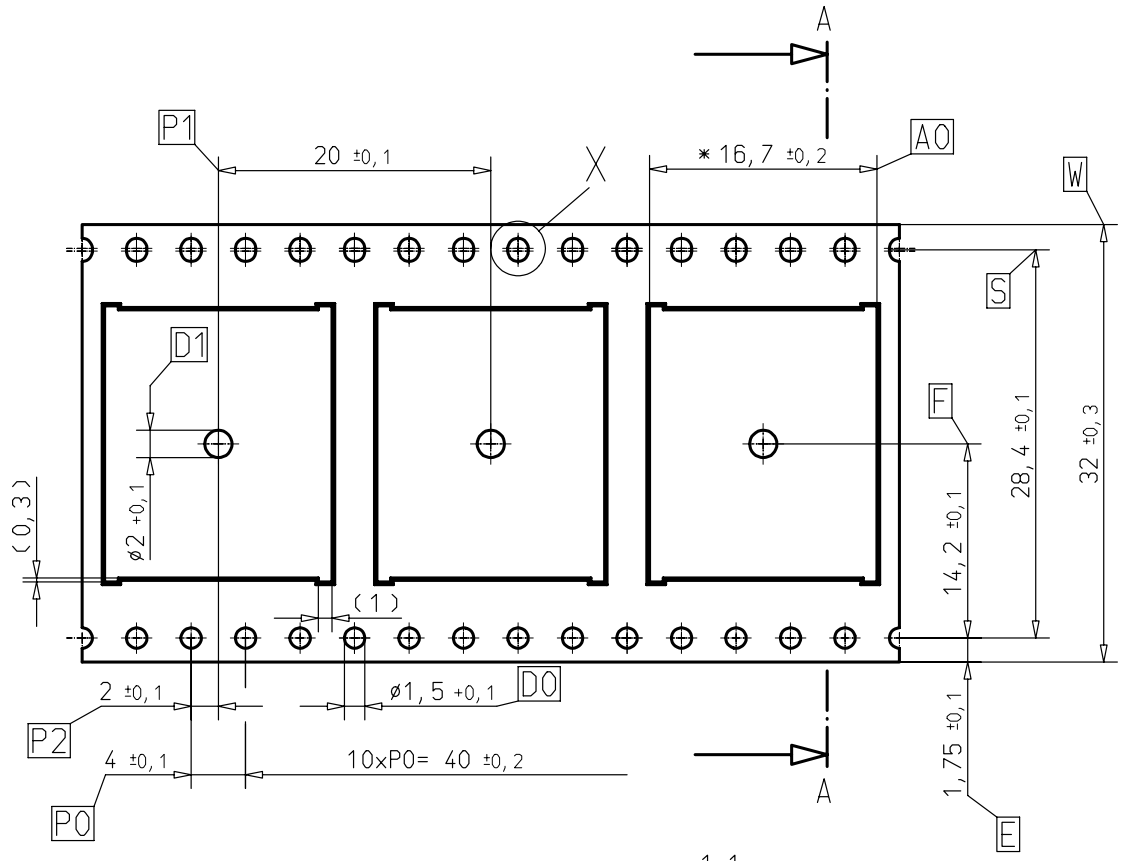


Figure 2: A1037-A tape specifications (1)

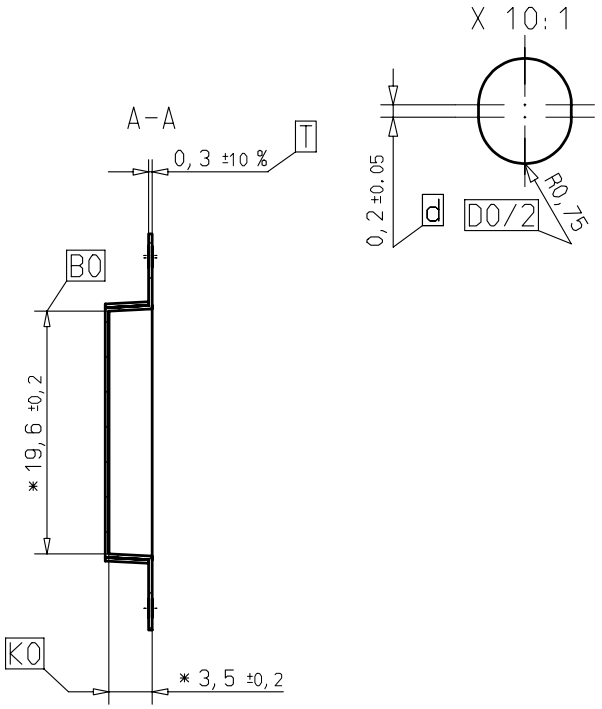


Figure 3: A1037-A tape specifications (2)

2.3 Additional Equipment

V23993EVA1037A	Evaluation Kit (including one module V23993A1037A)

Table 3: Additional equipment

A detailed description of the additional kit can be found in the according manuals.

3 Quick Start

In order to allow an easy and quick start with the modules A1037-A, this chapter provides a short overview on the most important steps to receive NMEA messages with position information on a serial port.

3.1 Minimum Configuration

The following picture shows a recommended minimum configuration for NMEA output and commands sent and received via an RS232 interface based on the GPS module A1037-A.

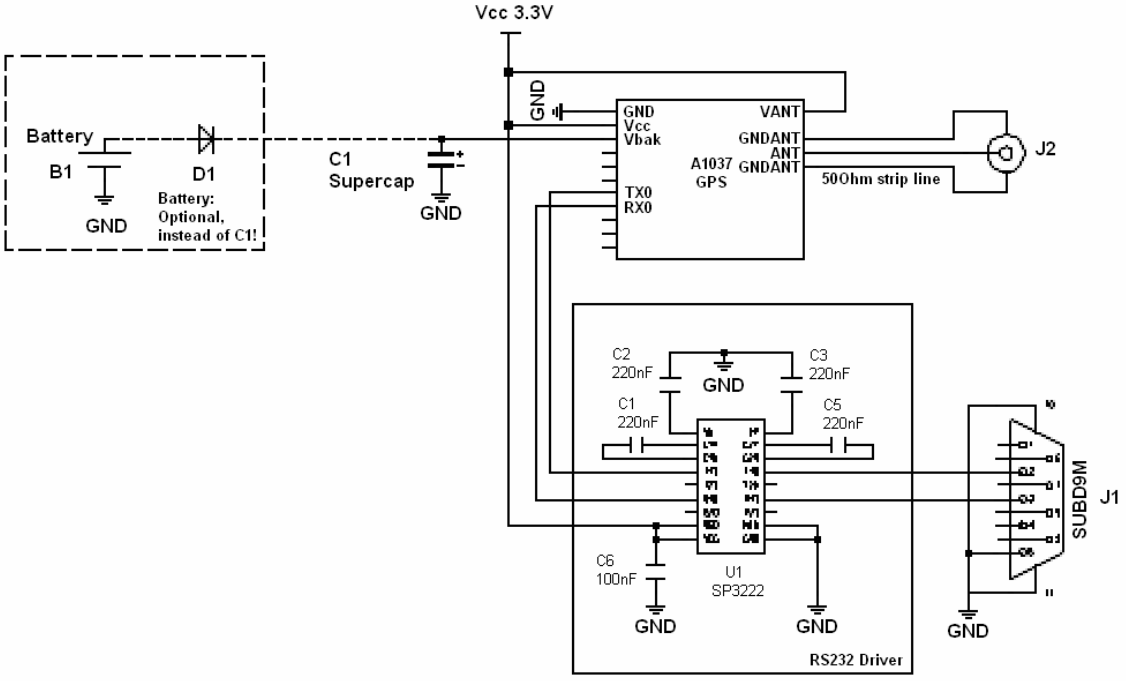


Figure 4: Recommended minimum configuration A1037-A

Remarks:

- Place C2 to C6 close to SP3222. For capacity values see datasheet of actual component used.
- Use 3.3V level shifter (SP3222 or equivalent).
- Use separate ground plane for antenna ground.
- Antenna input impedance is 50Ohm. Match as close as possible.
- Maximum allowed antenna current is 50mA. Consider a current limiter.
- A battery back-up circuit for the RTC (Real Time Clock) should be considered (see 10.6 Battery Back-up)!

NOTE: Please make sure that the A1037-A is either within an enclosure or additionally shielded to reduce the influence of temperature fluctuations often generated by airflow.

3.2 Antenna

It is recommended to use an active GPS antenna with supply voltage of 3 to 5VDC and a current draw of 50mA maximum. The quality of the GPS antenna chosen is of paramount importance for the overall sensitivity of the GPS system. An active antenna should have a gain ≥ 20dB and a noise figure ≤ 1.5dB, which applies to more than 95% of the active antennas available in the market.

3.3 Serial Port Settings

Using Pin P0.13 two different set of GPS NMEA out messages with two different baud rates can be selected.

CONF (P0.13)	NMEA Messages Set	Default
Leave unconnected / External pull-up	NMEA: GGA – VTG – GSA – GSV Baud rate: 4800 Transmit mode: on UTC second	X
External pull-down	NMEA: GGA – GSA – GSV - RMC – TG –TS - PA Baud rate: 57600 Transmit mode: on UTC second	

Table 4: NMEA configuration

This pin will be read by the software during the GPS software start-up only. Any changes in the setting afterwards will not affect the configuration.

The default configuration within the standard GPS firmware is:

- Serial 0 (NMEA) 4800 baud, 8 data bits, no parity, 1 stop bit, no flow control

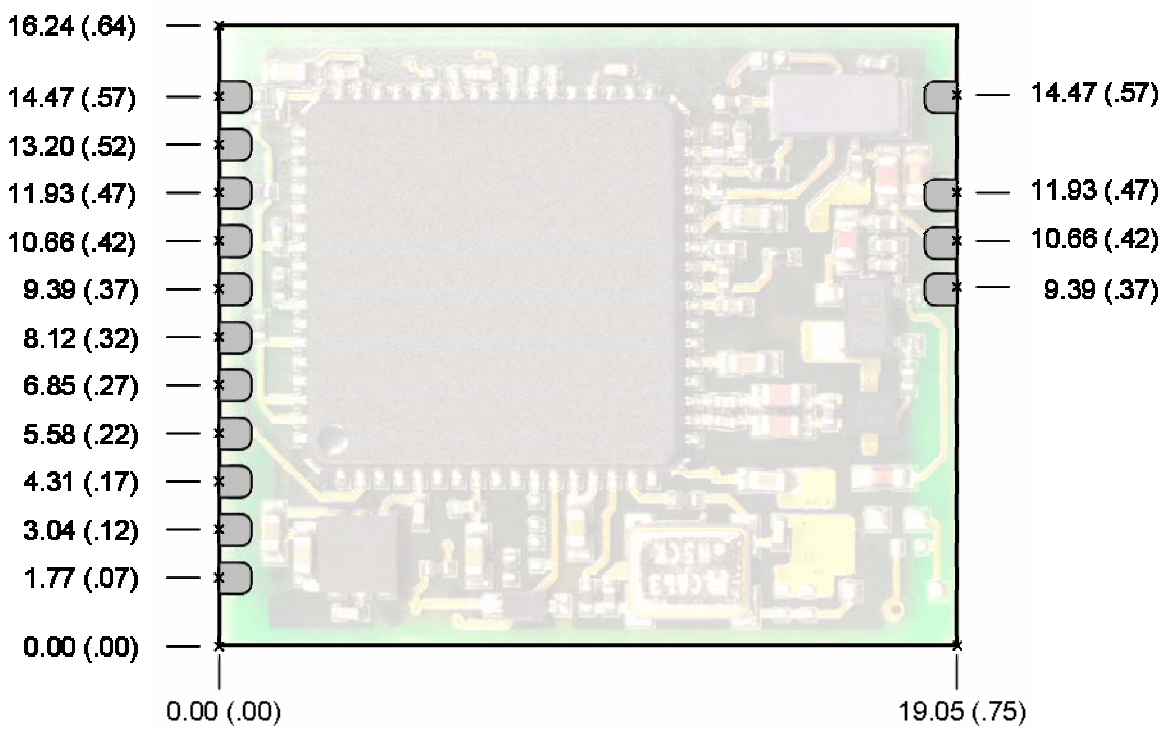
3.4 Improved TTFF

In order to improve the TTFF (Time To First Fix), it is recommended to support the RTC with a back-up super-capacitor (“supercap”) or a battery when no system power is available.

If the system or the GPS receiver alone should not be backed-up it is possible to support the restart procedure by providing position and date/time information to the module. This is described in the firmware manual. Please refer there to chapter “Start-up Support” in the document T.E. GPS Firmware A1037.

4 Mechanical Outline

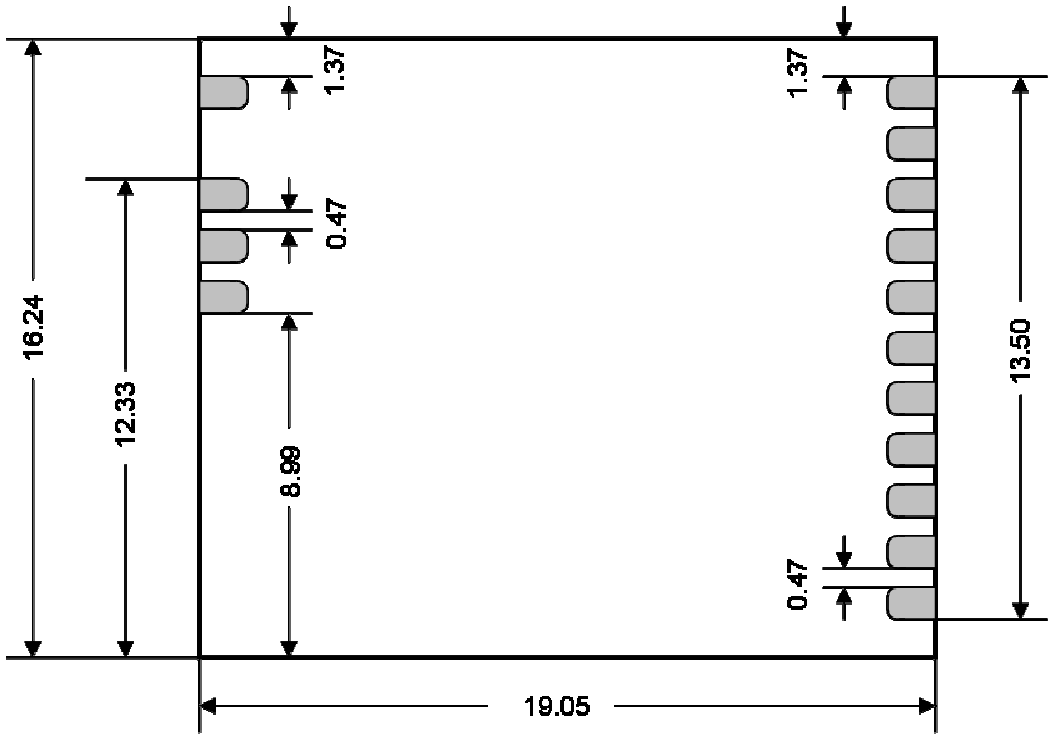
4.1 Details Component Side A1037-A



All dimensions in [mm (inch)]

Figure 5: Mechanical outline component side A1037-A

4.2 Details Solder Side A1037-A



Solder pad size: 1.4 x 0.9
All dimensions in [mm]

Figure 6: Mechanical outline solder side A1037-A

5 Pin-out Information

5.1 Layout A1037-A

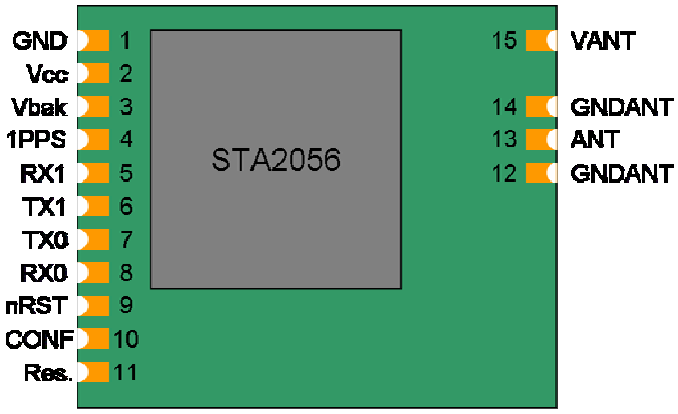


Figure 7: Pin-out information A1037-A

5.2 Description A1037-A Signals

Pin	Symbol	Description
1	GND	Ground (power supply)
2	Vcc	3.3 – 3.6 VDC (power supply)
3	Vbak	Back-up pin of module for “supercap” or battery (see below)
4	1PPS (P1.8)	1PPS (pulse per second) output
5	RX1 (P0.10)	Serial input 1 – reserved (leave open)
6	TX1 (P0.11)	Serial output 1 – reserved for debug (leave open)
7	TX0 (P0.9)	Serial output 0, NMEA out
8	RX0 (P0.8)	Serial input 0, NMEA in
9	nRST	Reset input
10	CONF (P0.13)	NMEA configuration - see chapter 3.3 Serial Port Settings
11	Res. (P0.14)	Reserved – leave open
12	GNDANT	Antenna Ground, do not connect to GROUND, connect to antenna shield (see below)
13	ANT	Antenna signal / Z=50 Ohm
14	GNDANT	Antenna Ground, do not connect to GROUND, connect to antenna shield (see below)
15	VANT	Power supply antenna – provide according voltage

Table 5: Pin description A1037-A

5.3 General Comments

The following comments should be considered for a design with and use of the module:

- Standard configuration of serial port (standard GPS software):
  Serial 0 (NMEA) 4800 baud, 8 data bits, no parity, 1 stop bit, no flow control
- Antenna (Antenna connected to Antenna Pin)
  Use ground pins (pin 12, pin 14) close to the antenna input for RF ground.

6 Electrical Characteristics

6.1 Operating Conditions

Pin	Description	Min	Typical	Max
2	Vcc	3.3V	3.3V	3.6V
	Current draw (without active antenna)		54mA	
	Input current in standby mode typical value at 20°C max. value at min. temperature	20µA	20µA	300µA
4	1PPS (1 pulse per second), reference GPS time		+120ns	
15	VANT (active antenna supply voltage) Antenna current	0V		5.5V 50mA
13	ANT (antenna pin)		Z_0=50Ω	
	Output pins VOH VOL	 Vcc-0.8V		 0.4V
	Input pins VIH VIL	 2.0V		 0.8V

Table 6: Operating Conditions

6.2 Absolute maximum ratings

Symbol	Parameter	Min	Max	Unit
Vcc	Power supply	-0.3	+3.6	V
Vin	Voltage to any pin	-0.3	+3.6	V
Iov	Input current on any pin	-10	10	mA
Itdv	Absolute sum of all input currents during overload condition		200	mA
Tst	Storage temperature	-40	125	°C
Vant	Antenna power supply	0	5.5	V

Table 7: Absolute maximum ratings

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

7 Mounting

This chapter covers the mounting of the A1037-A.

7.1 Proposed Footprint for Soldering

The following proposal of a footprint for soldering is assuming a stencil thickness of 150µm. ✕ marks the center of the through holes.

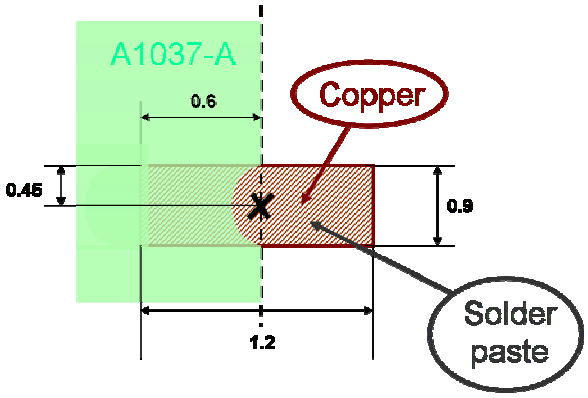


Figure 8: Soldering footprint proposal A1037-A

Please note that copper and solder paste footprint are identical. The final footprint has to be evaluated and qualified by the manufacturer according to the specific processes.

7.2 Recommended Profile for Reflow Soldering

Typical values for reflow soldering of the module in convection or IR/convection ovens are as follows:

Peak temperature	245°C
Average ramp up rate to Peak (183°C to Peak)	3°C / second max.
Preheat temperature 125 (±25°C)	120 seconds max.
Temperature maintained above 183°C	60 … 150 seconds
Time within 5°C of actual peak temperature	10 … 20 seconds
Ramp Down rate	6°C / second max.
Time 25°C to peak temperature	6 minutes max.

Table 8: Reflow soldering profile A1037-A

As results of soldering may vary among different soldering systems and types of solder and depend on additional factors like density and types of components on board, the values above should be considered as a starting point for further optimization.

8 Use of Antenna

8.1 Connection of RF Signal

The ANT pin is used to connect the receiver with the GPS antenna. The design of the antenna connection has to be done strictly according to RF design rules. A 50Ω PCB strip line is required. The following drawings shall explain the guidelines. A major rule is to keep the strip line as short as possible. Additionally, antenna ground (GNDANT) should be routed to the ground plane of the PCB (the ground plane is on a lower PCB layer) by via as demonstrated in the drawing.

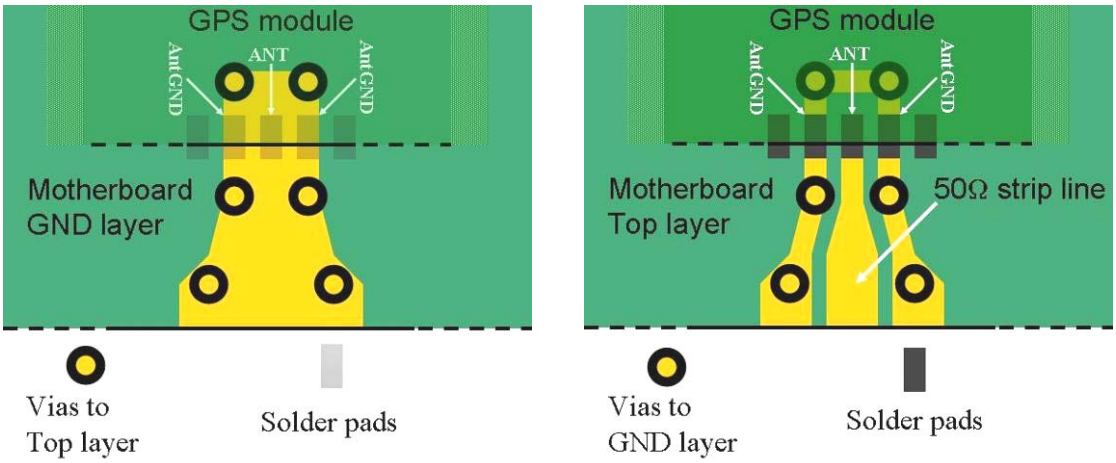


Figure 9: Antenna connector strip line A1037-A

In order to gain the impedance of 50Ω, the width of the strip line needs to be calculated. It depends on the thickness or height of the PCB layer (both parameters are shown in following drawing). For our calculation, we assume that the PCB material is FR4.

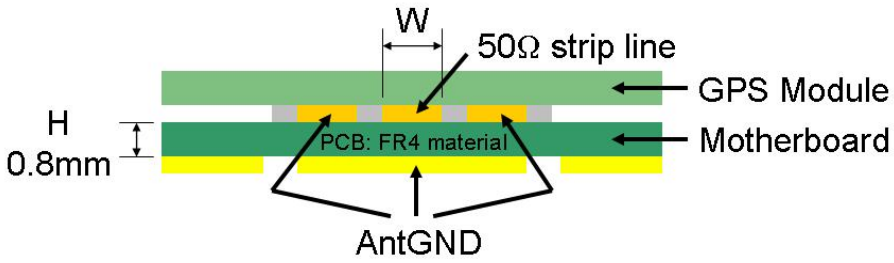


Figure 10: Strip line parameters A1037-A

In this case, the width should be about 1.8 times the height of the PCB:

$$W = 1.8 \times H$$

In our example, we would get a width of W = 1.8 x 0.8mm = 1.44mm.

8.2 Active Antenna

General GPS active antenna specification:

Limitations:

- Supply voltage according to voltage fed into VANT pin (5V max.)
- Supply current 50mA (max.)

Recommendations:

- Gain ≥ 20dB (should not exceed 35dB)
- Noise figure ≤ 1.5dB

The recommendations apply to the majority of active antennas that can be found in the market. Anyhow, the quality of the GPS antenna chosen is of paramount importance for the overall sensitivity of the GPS system.

The system design needs to reflect the supply voltage of the antenna. If the supply voltage is equal to Vcc, Vcc can be connected to VANT. If the antenna requires a different supply voltage, the antenna bias can be provided through the VANT pin.

9 Quality and Reliability

9.1 Environmental Conditions

Operating temperature	-30 … +70°C
Operating humidity	Max. 85% r. H., non-condensing, at 85°C
MSL JEDEC (Moisture Sensitivity Level)	3
Storage	6 months in original package.

Table 9: Environmental conditions

9.2 Product Qualification

Prior to product qualification the GPS receiver is preconditioned according to EIA/JEDEC standard JESD22-A113-B / Level 3.

Basic qualification tests:

- MSL Classification according to J-STD-020C (MSL3 @ 245°C)
- MSL Rework Compatibility according to J-STD-020C
- Temperature Cycling –30°C … +70°C
- Temperature Humidity Bias 70°C / 85% RH
- High / Low Temperature Operating –30° / +70°C
- High Temperature Operating Life +70°C
- Vibration Variable Frequency
- Mechanical Shock

Please contact Tyco Electronics for detailed information.

9.3 Production Test

Each module is electrically tested prior to packing and shipping to ensure state of the art GPS receiver performance and accuracy.

10 Applications and Hints

10.1 Minimum Configuration

Please refer to chapter 3.1 Minimum Configuration for details. In addition, for optimized start-up behavior it is strongly recommended to add a battery back-up circuit (see chapter 3.4)!

10.2 Antenna Status Adaptation

This chapter shall give assistance in designing a circuit for detecting if an antenna is connected to the module. The information about the antenna status can be derived from the ANTSTAT signal generated by this circuit. The examples use values for components that roughly result in the following ANTSTAT output:

- Logic low when: Iant < 9mA
- Logic high when: 9mA > Iant < 16mA
- Logic low when: Iant > 16mA

10.2.1 Antennas with Different Current Draw

The following circuit is a proposal on how you can feed an antenna with 3.3V and provide an output for the ANTSTAT pin. The value of the components may need an adaptation in the final application. For example, the input current of the chosen comperator goes into that equation. The thresholds defined in this circuit are quite close to the ones described above. Their value is determined by resistors R4, R5, and R3.

We strongly recommend simulating and testing your realized version before using it. In any case, it is the responsibility of the designer to test and verify the implementation.

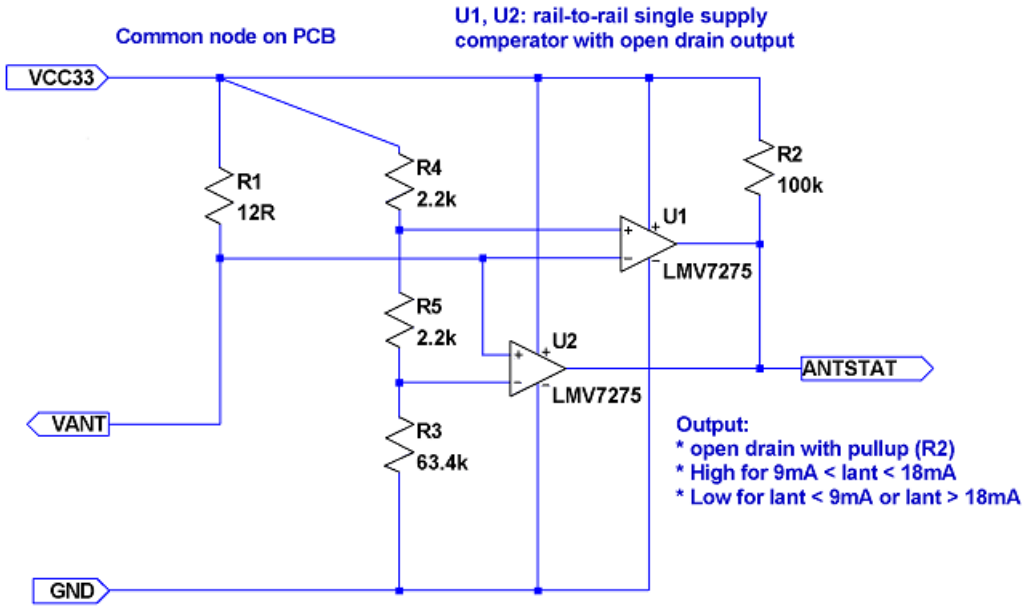


Figure 11: Application note: Antenna sensor adaptation

10.2.2 Antennas with Different Current Draw incl. Current Limiter

This proposal is similar to the first one, but includes a current limiter. Comments and notes as above apply.

We strongly recommend simulating and testing your realized version before use. In any case it is the responsibility of the designer to test and verify the implementation.

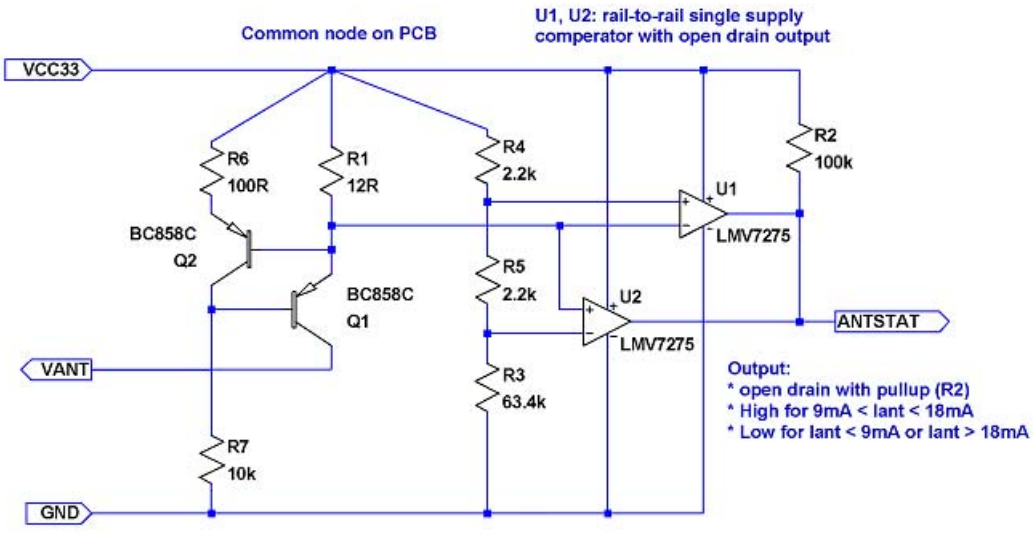


Figure 12: Application note: Antenna sensor adaptation with current limiter

10.3 VANT Pin (antenna voltage input pin)

The VANT pin is an input pin.

The supply voltage for an active GPS antenna has to be fed into the Vant pin. The easiest way to do that is to connect Vcc to VANT. The maximum current is 50mA.

Note: Shortcut between ANT and GND may damage the A1037-A GPS receiver module. This should be avoided by using an antenna current limiter.

Please find proposal for simple current limiter below. If other transistors are used, other resistor values may be necessary as well. We strongly recommend simulating and testing your realized version before using it.

The little schematics below work for Vcc from 3V to 5V. The antenna current will be limited to around 50mA.

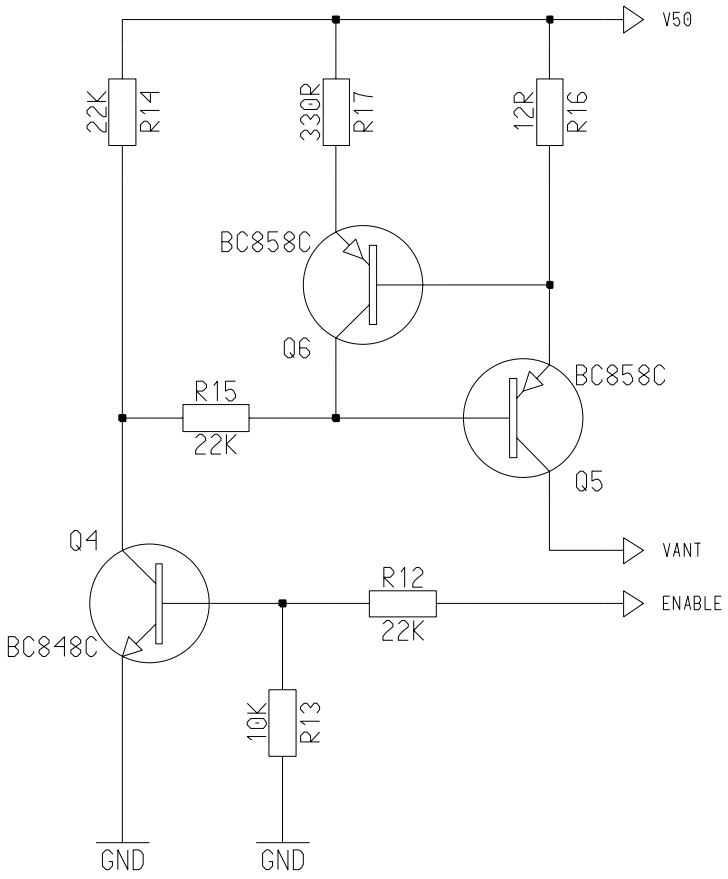


Figure 13: Application note: Antenna current limiter

10.4 1PPS pin (1 pulse per second pin)

The 1PPS pin is an output pin.

In addition to precise positioning, GPS also allows for accurate timing due to the synchronized atomic clocks in the GPS satellites. While the current date and time is transmitted in NMEA sentences, an exact and accurate timing signal is provided via the 1PPS pin of the A1037 modules.

10.5 Reset Signal

The nRST pin is an input pin.

The nRST pin can be used to generate a reset on the A1037-A module. Resetting the module will result in a restart of the complete firmware. All information stored in SRAM will still be valid.

10.6 Battery Back-up

This application note describes on how to back-up the RTC and the SRAM of the GPS receiver module. The basic of the first examples is to provide a back-up by a separate battery or a “supercap”. Here it has to be considered that the RTC is only backed as long as the voltage on the Vbak pin is higher than 2.9V.

While the “supercap” is charged thru the module during normal operation, the battery (primary cell) is decoupled thru a diode!

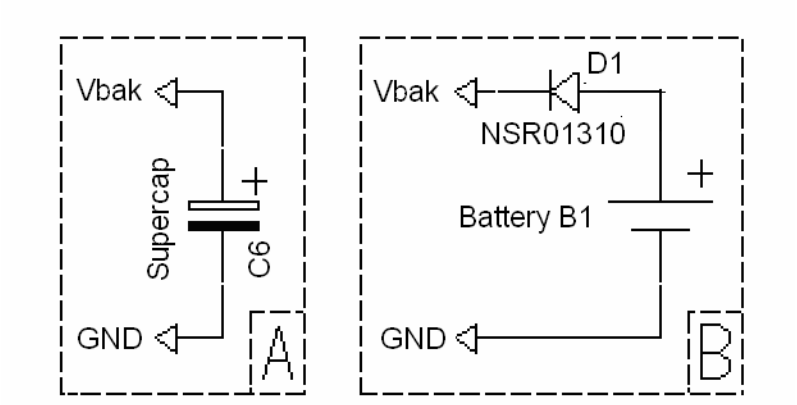


Figure 14: Application note: Module back-up

An alternative to this solution is to switch the supply voltage from the Vcc pin to the Vbak pin. Care needs to be taken that the there is no voltage outage during the switch-over phase!

11 Demonstration Kits

11.1 Evaluation Kit A1037-A

For demonstration and easy evaluation of GPS performance Tyco Electronics offers a Demonstration Kit (including one GPS A1037-A module). It contains a USB interface with according drivers to connect easily to a PC. The USB interface is an extension of the serial port 0, therefore sending NMEA sentences and accepting commands. At the same time it provides power to the module. Accompanied by an antenna it offers a ready-to-go set.
For the development of new software and applications the Evaluation Kit also provides NMEA messages on C-MOS level via a terminal plug.

For further information please contact Tyco Electronics.

12 Related Information

12.1 Contact

This manual was created with due diligence. We hope that it will be helpful to the user to get the most out of the GPS module.

Anyway, inputs about errors or mistakable verbalizations and comments or proposals to TYCO Electronics, Power Systems in Munich, Germany, for further improvements are highly appreciated.

Tyco Electronics
Power Systems
Tyco Electronics Corporation
Power Systems
Finsinger Feld 1
85521 Ottobrunn, Germany
Tel.: +49 89 6089 838
Fax: +49 89 6089 835

gps@tycoelectronics.com.
www.tycoelectronics.com/gps.

Further contact addresses:
info.gps@tycoelectronics.com.
support.gps@tycoelectronics.com.
sales.gps@tycoelectronics.com.

12.2 Related Documents

- Manual: T.E. GPS Firmware A1037-A (TYCO)
- Manual: T.E. GPS Evaluation Kit EVA1037-A (TYCO)

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